

130T-1

SERVICING SMALL ENGINES

AG 130-T

UNIT OBJECTIVE

After completion of this unit, students will understand the basic operation of small engines and power equipment and perform basic maintenance and service procedures on a small engine. This knowledge will be demonstrated by completion of assignment sheets and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Describe the maintenance of small engines, with respect to air cleaner, lubrication, and fuel.
2. Follow safe operation guidelines when using small engine equipment.
3. Describe the basics of engine operation; starting, stopping, and controls.

ENGINE OPERATION

A. Internal combustion engines can be classified either according to the type of fuel used to power them or by the cycle rotation of the engine. There are currently four different classifications of internal combustion engines that are in use today: Gasoline, two-stroke and four stroke. Diesel, two-stroke and four stroke.

1. Two-stroke engines are commonly used in small hand held power machinery such as chain saws, weed eaters, brush cutters, power augers and older boat motors.
2. Four-stroke engines are commonly used in lawnmowers, roto-tillers, newer boat motors, and other forms of wheel mounted small engine equipment.
3. In the two-stroke engine, lubrication is generally provided by oil mixed with the fuel.
4. Four-stroke engines have a separate reservoir for oil.

B. The Otto cycle (All four steps take place in all engine types).

1. Intake

- a. Diesel engines intake air only into cylinders.
- b. Gasoline engines intake both air and fuel into cylinders.

2. Compression

- a. Diesel engines compress air only.
- b. Gasoline engines compress both air and fuel within the cylinders.

3. Ignition

- a. Diesel engines ignite the air-fuel mixture spontaneously, due to the heat of compression.
- b. Gasoline engines ignite the fuel-air mixture with a spark from the spark plug.

4. Exhaust

- a. Both diesel engines and gasoline engines remove products of combustion (exhaust) by the upward movement of the piston.
- b. Some diesel engines remove exhaust with a blower in addition to removing it with the upward motion of the piston.

C. Basic design concept

1. Two-stroke cycle of operation

- a. A two-stroke engine utilizes one revolution of the crankshaft between each power impulse.
- b. This engine completes all four of the steps of the Otto cycle in only one revolution of the crankshaft.
 - 1) Intake and compression occur primarily during the up stroke (vertical cylinder orientation).
 - 2) Power and exhaust occur primarily during the down stroke (vertical cylinder orientation).
 - 3) Some overlap of the intake and exhaust parts of the cycle occur on a ported two-stroke engine such as a small chain saw or leaf blower.

2. Four-stroke cycle of operation

- a. The four-stroke engine utilizes two revolutions of the crankshaft between power impulses.
- b. This engine provides an individual piston stroke (up or down) to accomplish the complete Otto cycle.
 - 1) Intake - down stroke of piston
 - 2) Compression - up stroke of piston
 - 3) Power - down stroke of piston
 - 4) Exhaust - up stroke of piston
- c. The four-stroke engine must utilize a valve system in order to allow gases to enter the cylinder and escape to the atmosphere.
 - 1) The intake valve provides an opening for incoming gases to enter the cylinder and must be timed correctly for the Otto cycle operation (usually open approximately 215 degrees of crankshaft rotation).
 - 2) The exhaust valve opens to allow burned exhaust gases to escape to the atmosphere (usually open approximately 235 degrees of crankshaft rotation); it is also timed to correctly open in the Otto cycle.

D. Daily pre-start check

- 1. Check for leaking coolant, lubricant, and fuel.

130T-4

2. Check fuel tank level.
 - a. Never let a diesel run out of fuel.
 - b. Drain water and sediment from fuel sediment bowl on gasoline engines.
3. Check cooling fins on air cooled engines for dirt and debris. Check coolant level in radiator of water cooled engines.
 - a. Coolant should be about one inch below the top of radiator cap.
 - b. Make sure the percentage of antifreeze in the water is adequate by measuring the specific gravity with a radiator hydrometer.
4. Check V-belt (fan belt) tension and condition.
5. Check oil level (four-stroke).
 - a. Make sure oil is not grayish (water in oil).
 - b. Add proper engine oil as needed (consult operator's manual). Be careful not to add oil past the "full" mark on the dipstick.
 - c. Some engines can be checked while running; the operator's manual or dipstick will indicate if this is so. Those that are checked while running show level above "full" when not running.
 - d. Some older engines have plugs in place of dipsticks.
6. Check transmission and hydraulic oil levels if applicable.
7. Check and clean air cleaner.
8. Check condition of all air intake hoses and system.
9. Check water level and terminals of battery.
10. Check tire pressure and condition.
11. Check for loose bolts and nuts, tighten as required.
12. Grease all lube points.

D. Starting a gasoline engine

1. Provide adequate ventilation if engine is to be started inside.
2. Check that fuel supply valve is turned on.
3. Place transmission shift lever in neutral or park.
4. Set speed control lever (hand throttle) at 1/4 to 1/3 open.
5. Depress clutch pedal or lever if so equipped.
6. Pull out choke control if engine is cold.
7. Turn ignition switch to on position and crank engine no more than 30 seconds at a time. For pull start engines, pull cord with a sharp, smooth motion. Make sure starter mechanism engages before pulling the rope.

130T-5

8. Push in choke control after engine has started and warmed.
9. Allow engine to run at a moderately fast speed (2,000 rpm). Slowly release the clutch while the transmission still in neutral if machine is equipped with a clutch.
10. Check all gauges and warning lights for normal readings.
11. Allow the engine to warm up for one or two minutes before doing work.

E. Small engine operating safety.

1. Always obtain permission from your teacher before starting an engine.
2. Do not wear open toed shoes while operating power equipment.
3. Do not wear loose fitting clothing that may become entangled in moving parts.
4. Keep safety guards over moving parts in place.
5. Do not touch hot exhaust parts.
6. Operate engines in a well ventilated area.

F. Trouble shooting

1. Trouble shooting is the art of finding the source of engine problems. If an engine fails to start, check for fuel in the tank and oil in crankcase.
2. Check compression by removing the spark plug and covering plug hole with thumb. Crank the engine, air pressure should be felt on the thumb. If there is no compression, add a small amount of oil through the plug hole. This seals the rings. If compression increases, rings are not sealing properly, and valves are. If no change is evident, both valves and rings may be at fault. If the engine has been idle for some time, the "Shot of oil" may be all that is necessary to get the engine to run. To correct low compression it is necessary to overhaul the engine.
3. If engine fails to start but compression is good, check ignition spark as follows:
 - a. Place spark tester in series with the secondary coil wire and spark plug and test for spark. If spark occurs in the spark tester, the coil is functioning properly but there still might be a problem with the spark plug itself. (See page 130T-17)
 - b. If no spark occurs then disconnect from the spark plug and connect to a head bolt.
 - c. If spark still does not occur, check the primary ignition system for problems. If spark does occur, replace the spark plug.

130T-6

4. Engine fails to start but compression and spark are adequate remove air cleaner. Squirt small amount of fuel in carburetor (cool engines only!). If engine starts choke is inoperative or fuel blockage has occurred. To check for fuel blockage answer the following:
 - a. fuel at carburetor?
 - b. filter plugged?
 - c. fuel valve open?
 - d. fuel line plugged?
 - e. dirt or water in fuel system?
 - f. correct fuel/oil mix for two-stroke?
 - g. bolts and screws tight?
 - h. is the carburetor properly adjust according to the manual?
5. An engine with good compression, spark, and fuel delivery should start.

ACTIVITY:

1. Examine a variety of small engine powered equipment and determine whether the equipment is powered by a two-stroke or four-stroke engine.
2. Develop a list of uses for small engines.
3. Go through engine starting procedures with students and have each student start an engine.

SMALL ENGINE MAINTENANCE

A. Importance of preventive maintenance

1. The leading cause of premature failure in agricultural machines is a lack of preventive maintenance.
 - a. Preventive maintenance is most important when the work load is heaviest because the financial losses will be greatest if machinery is down at crucial times.
 - b. While preventive maintenance cannot completely prevent the possibility of machine failure, it reduces it to a minimum.
2. Preventive maintenance saves money on the total cost of operating machinery.
 - a. An engine tune-up can save up to 15% in fuel consumption and increase maximum power by more than 10%.
 - b. Regular maintenance of other components saves money in repairs and prolongs the working life of equipment.
3. Well-maintained equipment is safer to operate.
 - a. Trying to fix broken-down equipment in the field increases the likelihood of accidents and injuries, as, for example, when the operator hurriedly reaches into the moving parts of a machine.
 - b. Poorly functioning brakes or steering can lead to loss of control of the machine and serious accidents and injuries.
 - c. Poorly functioning equipment takes more time and effort to operate and also prolongs the time required to complete the task at hand; these factors contribute to operator fatigue which, in turn, greatly increases the likelihood of accidents and injuries.
4. Systematic preventive maintenance also results in higher resale or trade-in value for tractors and other agricultural equipment.

B. Service schedules

1. Each machine's operator's manual specifies the service schedule exactly tailored to that particular machine.
2. Adhering to the manufacturer's recommended service schedule and also maintaining complete and accurate service records are essential to insure that service is regularly performed at the recommended intervals.

3. Service schedules usually have 10-hour, 50-hour, 100-hour, 250-hour, 500-hour, and 1000-hour intervals or service periods.
4. Service records should be kept in a visible, handy place so they can be conveniently referred to when necessary and also constantly remind the machine operators to keep them up to date.

C. Fuel filter maintenance

1. The purpose of fuel filters is to remove water, sediment, air bubbles, and abrasive particles from the fuel before it enters the carburetor (gasoline engine) or the fuel injection pump (diesel engine).
2. Air in the fuel lines of a diesel engine can cause the engine to run rough or not start.
3. Water and dirt are the major enemies of a fuel system, especially in diesel engines.
 - a. Water cause parts to rust, and even a very small amount of rust can damage injectors.
 - b. Water interferes with the proper metering of fuel, thereby causing the engine to run rough.
 - c. Dirt and sediment clog fuel lines and grind away the injection pump's fine fitted parts.
4. Refer to the operator's manual of the equipment for the recommended fuel filter service interval.

D. Importance of cleaning air filters

1. Air cleaners properly serviced remove abrasive materials from the intake air without reducing the huge volume of air required for adequate fuel combustion.
 - a. The air-fuel ratio of a gasoline engine varies greatly. It may be as rich as 2:1 when choking the engine during cold weather starting. A lean mixture (17:1) can give fuel economy but will result in decreased power and an engine that will run hot. A 15:1 air-fuel ratio provides the most economical engine operation (a medium-speed ratio).
 - b. The air-fuel ratio of a diesel engine varies greatly, according to engine speed. At idle speeds the ratio could be as lean as 100:1 or 20:1 for full throttle speeds.

130T-9

2. Dirt or other abrasive materials that enter in the intake air mix with the oil on the cylinder wall forming an abrasive solution, which rapidly wears cylinders, piston rings, and other engine parts.
3. Agricultural equipment usually works in very dusty conditions requiring frequent servicing, at least every 10 hours.

E. Cleaning a dry element air cleaner

1. Inspect the air cleaner and intake system for leaks where dust may enter.
2. Remove the filter element and tap it on the heel of your hand to remove the dust. (Do not tap the element against a hard surface.)
3. Use compressed air to clean the element if tapping does not remove dust. Direct the air up and down the element pleats, blowing from the inside to the outside of the element. If you hold the air nozzle too close you can blow a hole in the paper element.
4. If compressed air is not available, remove the dust with water. Flush the dirt from the inside to the outside of element, then allow the element to dry before reassembling.
5. If oil still remains on the element after following the above steps, soak and gently agitate the element in lukewarm water and filter element cleaner.
6. Rinse the element cleaner off with water (40 psi or less); shake off the excess water, then allow the element to dry.
7. NEVER use fuel oil, gasoline, or solvent to clean a dry element.
8. Check the filter element gasket for damage.
9. If the element or the gasket is damaged, replace it.
10. Clean the inside of the air cleaner body with a clean, damp cloth.
11. Place the element into the cleaner body and carefully reassemble the air cleaner.
12. Record the date and the number of hours on the engine when you serviced the air cleaner.

F. Cleaning an oil foam air cleaner (See page 130T-18)

1. Wash foam element in liquid detergent and water to remove dirt.
2. Wrap foam in cloth and squeeze dry.
3. Saturate foam with engine oil. Squeeze to remove excess oil, until oil no longer drips from the foam. (DO NOT OIL pre-cleaners THAT ARE IMPRINTED "DO NOT OIL.")

G. Importance of changing oil and oil filters. CHECK OIL LEVEL EVERY TIME YOU PUT GAS IN THE TANK!!!!!!!!!!!!!!

1. What is the function of engine oil?

- a. It reduces wear by reducing friction.
- b. It cushions loads by absorbing shock.
- c. It seals the space between the cylinder wall and the piston rings.
- d. It cools engine parts by absorbing heat as it circulates.
- e. It cleans working surfaces.
- f. It provides rust protection by sealing engine parts from the air.
- g. It neutralizes acids which can corrode metal.

2. Why change engine oil?

- a. Oil loses its lubricating qualities as its additives wear out and it picks up dirt and other abrasive material.
- b. Black crankcase oil does not indicate that an oil change is due.
- c. Check the operator's manual for the manufacturer's recommended oil change schedule to insure that the oil is changed before the additives wear out.

H. Changing the oil and oil filter - After each 25 hours of engine use, the crankcase oil should be drained while the engine is warm. Hot oil flows easily and carries the contaminants with it.

- 1. Start the engine, and let it run until the normal operating temperature is obtained.
- 2. Turn off the engine and remove the drain plug from the oil pan.
- 3. Clean off metal particles from the oil drain plug (some are magnetized).
- 4. Drain the oil for at least five minutes.
- 5. Before removing the oil filter, clean dirt off the filter and surrounding area.
- 6. If the filter is self-contained, remove it with an oil filter wrench. If the filter has a reusable bowl, loosen filter bowl and remove the filter cartridge.
- 7. Throw away the used filter and clean the reusable bowl and base with solvent.
- 8. Install a new oil filter or reassemble the old filter with a new cartridge.
- 9. Replace the drain plug in the oil pan.
- 10. Fill the crankcase with the manufacturer's recommended type of new oil.
- 11. Start the engine, and operate it for a few minutes at low RPM.
- 12. Watch the oil pressure gauge or light immediately after starting to verify oil pressure, and check for leaks around drain plug and filter.
- 13. Turn off the engine and allow a few minutes for the oil to drain back into the oil pan, then check the oil level on the dipstick.
- 14. Wipe oil off the tools dispose of empty oil cans, and use sawdust to absorb any oil spilled on the floor. Recycle the used oil.
- 15. Record the date of service and the number of hours on the engine.

ACTIVITY:

1. Clean the air filter on available engines.
2. Change the oil and oil filter on available engines.
3. Test the spark in an engine with a spark tester.
4. Provide students with equipment and manuals. Students can review manuals, start and operate equipment, and make a presentation to the class on the appropriate pre-operation check, starting, operation and safety.
5. Practice trouble shooting disabled engines.

References:

Burke, Stanley R., & Wakeman, T. J. (1990). MODERN AGRICULTURAL MECHANICS (2nd ed.). Danville, IL:Interstate Publishers.

Cooper, E. L. (1997). AGRICULTURAL MECHANICS: FUNDAMENTALS AND APPLICATIONS, 3ed EDITION. Albany, NY: Delmar Publishers.

Jacobs, C. D., & Harrell, W. R. (1983). AGRICULTURAL POWER AND MACHINERY. New York: McGraw-Hill.

Briggs & Stratton REPAIR MANUAL FOR SINGLE CYLINDER 4-CYCLE ENGINES

Special material and equipment:

Lawnmowers, weed eaters, chain saws and other gasoline or electric powered equipment, including sample engines of both the two-cycle and four-cycle type. Spark tester, air filters, spark plug wrench.

Name _____

Date _____

Score _____

SMALL ENGINE MAINTENANCE, EXAM

Multiple Choice, Choose the most correct answer for the following questions.

1. _____ Which of the following items do NOT need to be checked before starting a small engine?
 - a. oil
 - b. gasoline
 - c. air cleaner
 - d. spark plug

2. _____ Which engine runs at a higher temperature?
 - a. A two cycle engine
 - b. A four cycle engine

3. _____ How many revolutions does it take to complete a full cycle in a two stroke engine?
 - a. 1 revolution
 - b. 2 revolutions
 - c. 3 revolutions
 - d. 4 revolutions

4. _____ How many revolutions does it take to complete a full cycle in a four stroke engine?
 - a. 1 revolution
 - b. 2 revolutions
 - c. 3 revolutions
 - d. 4 revolutions

5. _____ Having grayish oil in the crankcase indicates?
 - a. Water in the gasoline
 - b. Water in the crankcase
 - c. Old oil
 - d. Gasoline in the crankcase

6. _____ Which of the following safety procedures can be ignored?
- a. Do not wear open toed shoes while operating power equipment.
 - b. Keep safety guards over moving parts in place.
 - c. Operate engines in a well ventilated area.
 - d. None of the above.
7. _____ Preventive maintenance is the most important when the _____.
- a. work load is heaviest
 - b. equipment is not being used
 - c. before equipment goes into storage
 - d. work load is the lightest
8. _____ Regular engine services should be done _____.
- a. when ever the engine looks dirty
 - b. after every tenth time being used
 - c. consult the owners manual
 - d. one a year
9. _____ The purpose of an air cleaner is to _____.
- a. keep water from getting into the engine
 - b. filter gasoline
 - c. remove abrasive materials form the air
 - d. slow the engine down
10. _____ Which of the following is NOT a function of engine oil.
- a. reduces wear by reducing friction
 - b. cools engine parts by absorbing heat
 - c. seals the space between the cylinder wall and the piston rings
 - d. used a solvent

Fill in the blanks and short answer

11. Name the four strokes in a four cycle engine.

_____, _____, _____, _____

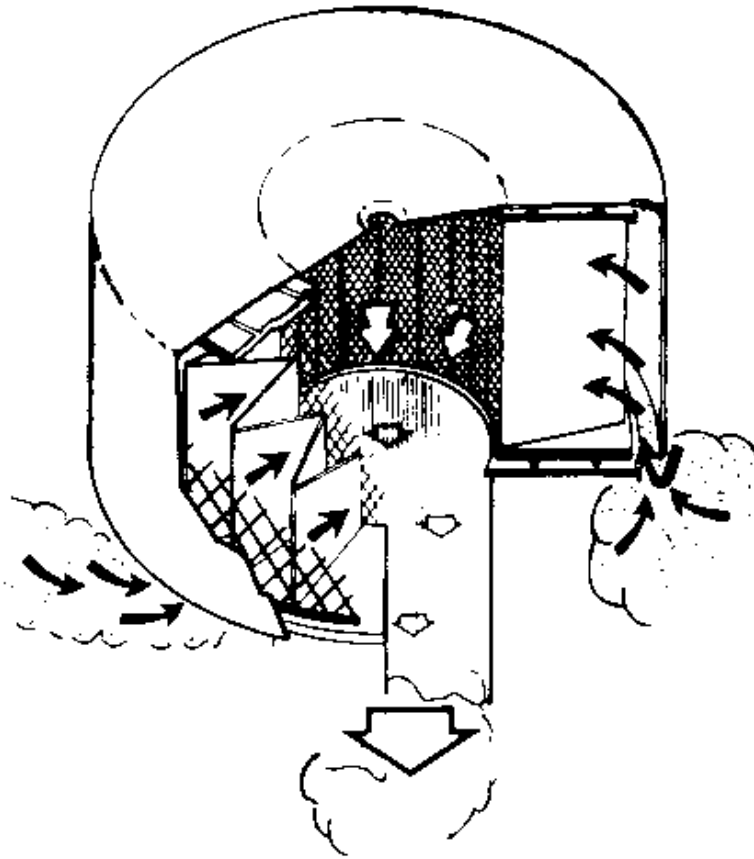
12. How often do you check the oil in a small gas engine?

Answer Sheet

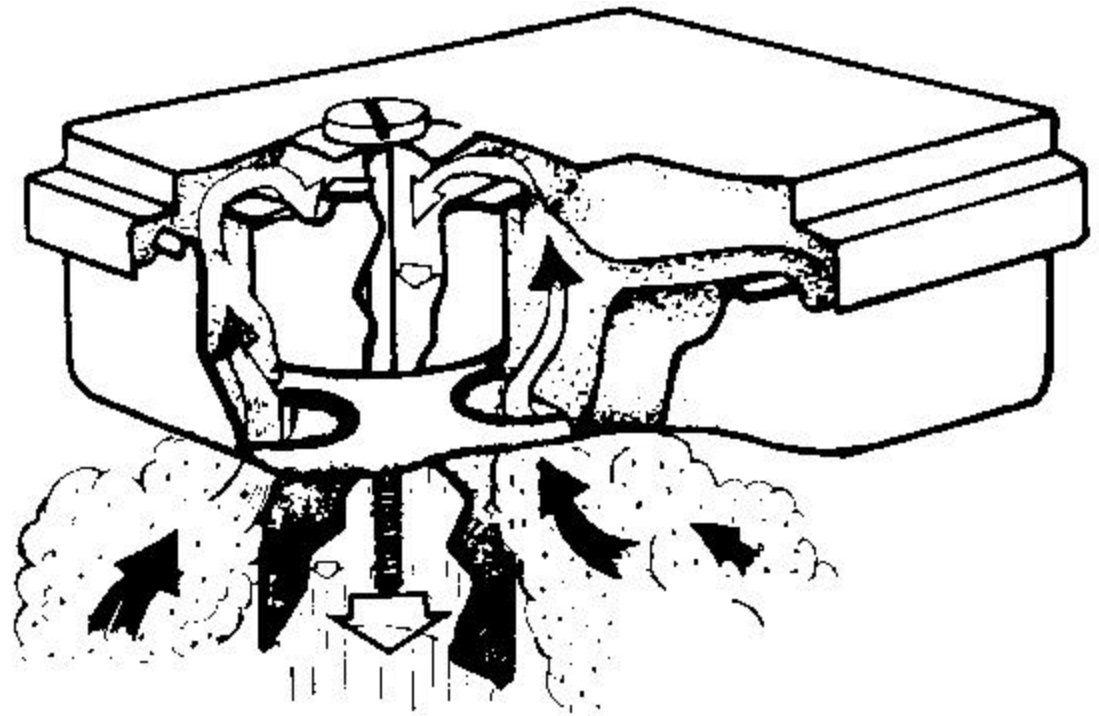
1. D
2. A
3. A
4. B
5. B
6. D
7. A
8. C
9. C
10. D
11. Intake, Compression, Power, Exhaust
12. Every time you put gas in the tank.

130T-15

TYPES OF AIR FILTERS



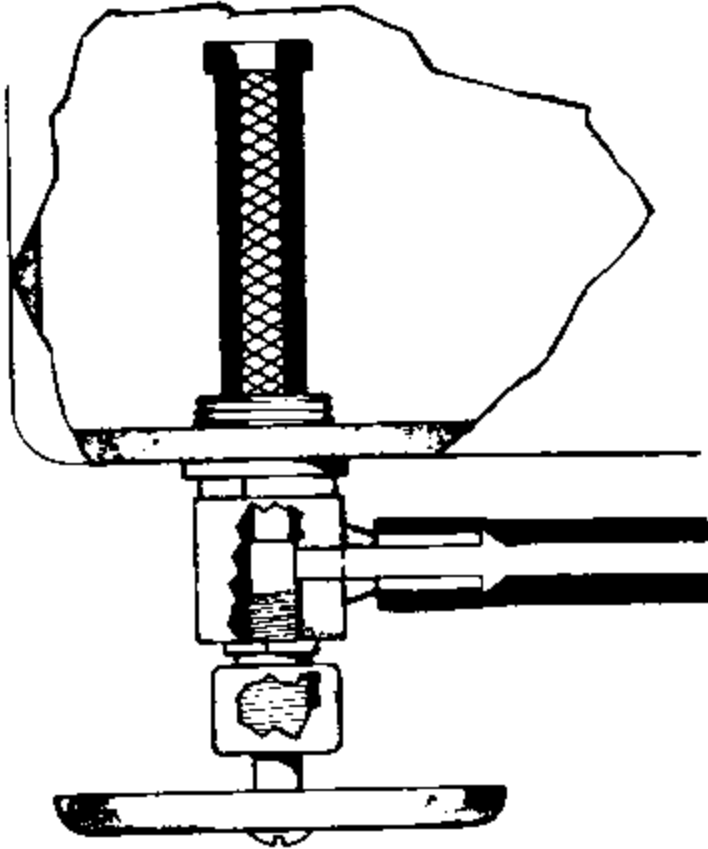
DRY-FILTER



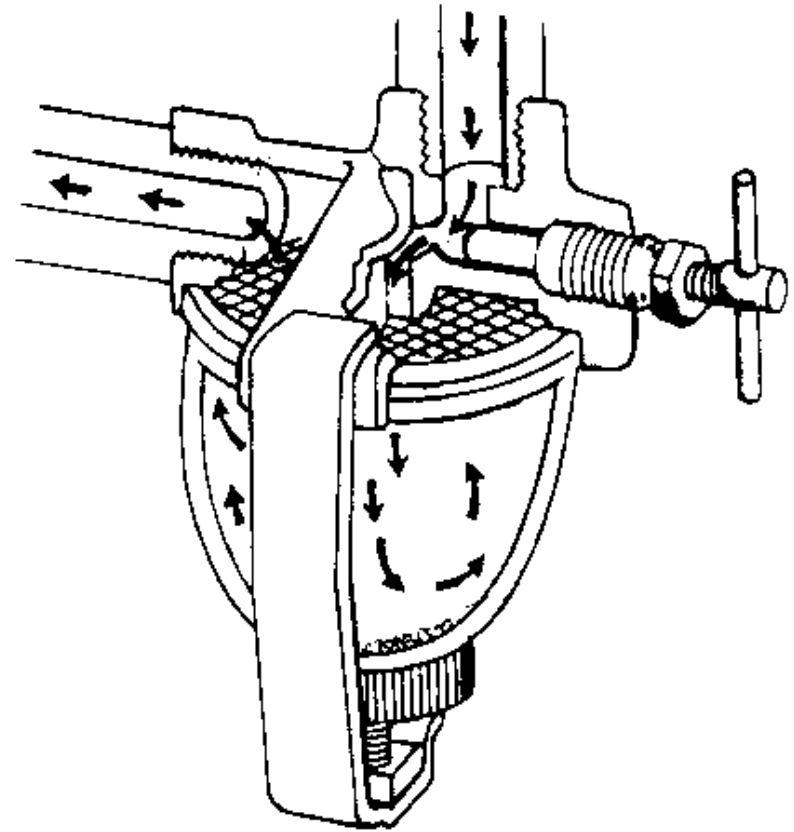
OILED-FILTER

130T-16

TYPES OF FUEL FILTERS



SCREEN IN FUEL TANK

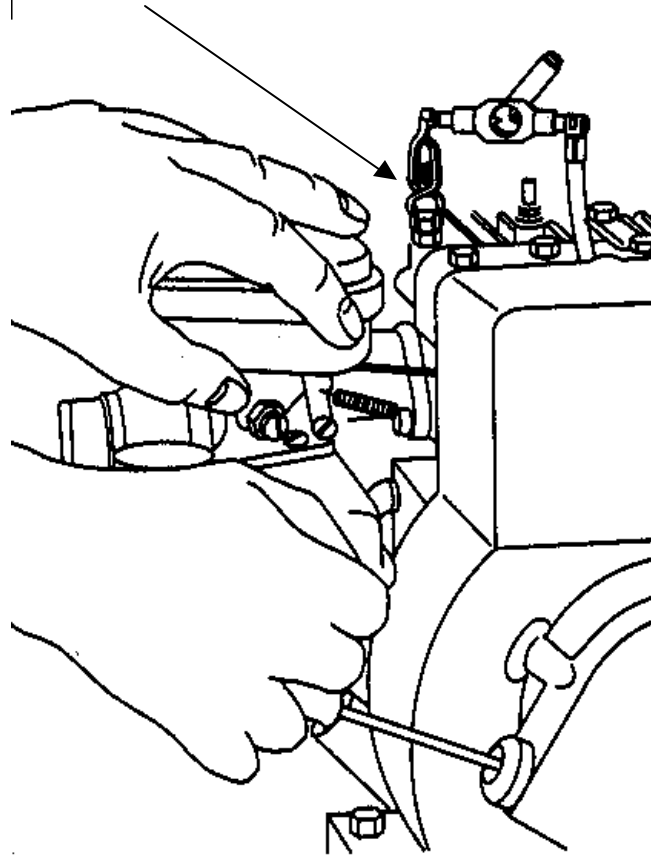


SEDIMENT BOWL

130T-17

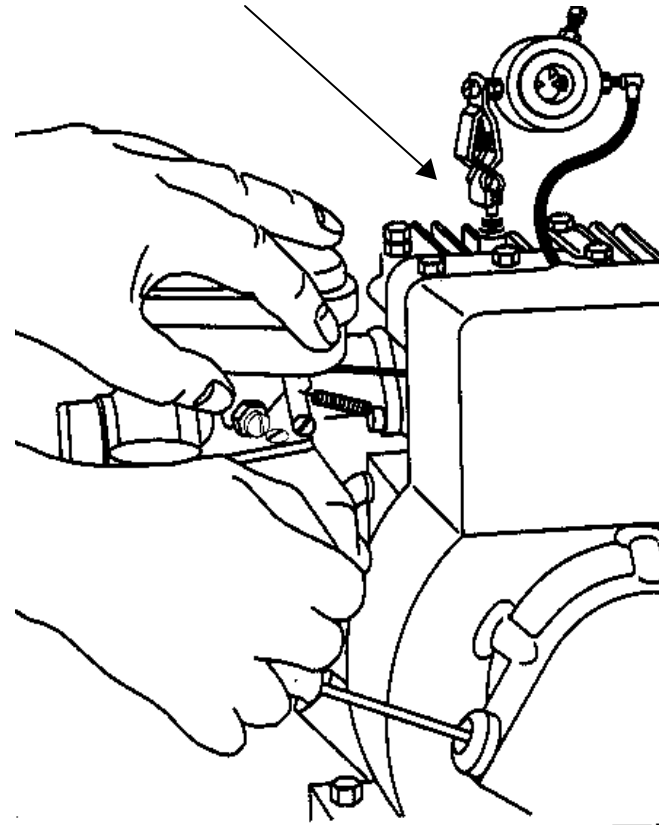
SPARK TESTING

TESTING IGNITION SYSTEM



ATTACH TESTER TO HEAD BOLT

TESTING SPARK PLUG



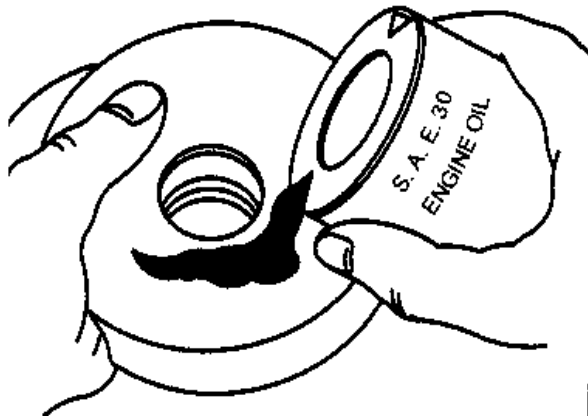
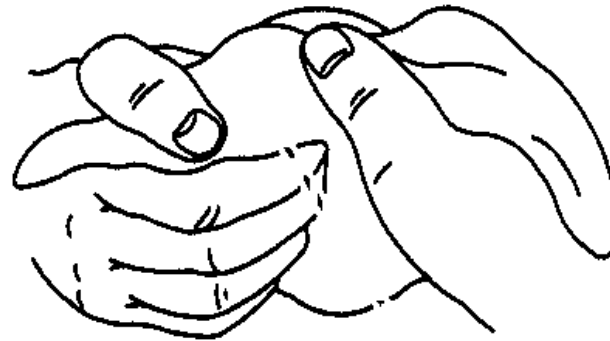
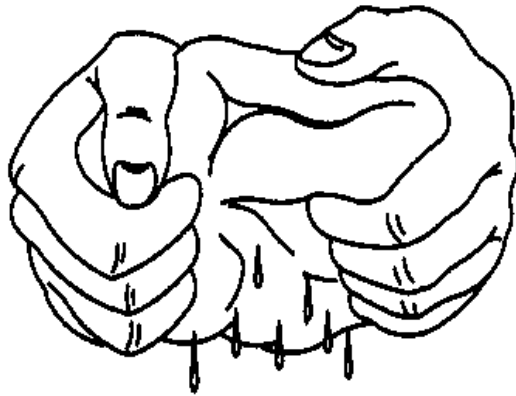
ATTACH TESTER TO SPARK PLUG

130T-18

CLEANING AN OIL FOAM AIR CLEANER

CLEAN WITH DETERGENT AND WATER

WRAP IN CLOTH AND SQUEEZE DRY



SATURATE WITH ENGINE OIL



SQUEEZE UNTIL NO MORE OIL COMES OUT